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California Environmental Protection Agency



Spark-Ignition Marine ~~Vessel~~Watercraft Evaporative Emissions Test
Procedure

TP - 1501

Test Procedure for Determining Diurnal Evaporative
Emissions from Spark-Ignition Marine ~~Vessel~~Watercrafts

Adopted Date: XXX

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**TP-1501
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**California Environmental Protection Agency
Air Resources Board**

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A set of definitions common to all Certification and Test Procedures is in Title 13, California Code of Regulations (CCR), section 2752 et seq. These definitions apply to all applicable instances in this test procedure.

For the purpose of this procedure, the term "ARB" refers to the California Air Resources Board, and the term "Executive Officer" refers to the ARB Executive Officer or his or her authorized representative or designate.

1. APPLICABILITY

This Test Procedure, TP-1501, is used to determine the diurnal evaporative emissions from spark-ignition marine ~~vessel~~watercrafts. This Test Procedure is proposed pursuant to sections 43013, 43018, 39600, and 39601 of the California Health and Safety Code (CH&SC), and is applicable in all cases where spark-ignition marine ~~vessel~~watercrafts are sold, supplied, offered for sale, or manufactured for use in the State of California.

1.1 Requirement to Comply with All Other Applicable Codes and Regulations

Certification or approval of any evaporative emission control system by the Executive Officer does not exempt the engine or evaporative emission control systems from compliance with other applicable codes and regulations such as state and federal safety codes and regulations.

1.2 Safety

This test procedure involves the use of flammable materials and possibly hazardous operations and should only be conducted by or under the supervision of those familiar and experienced in the safe use of such materials and operations. Appropriate safety precautions should be observed at all times while performing the test sequences in this test procedure.

2. PERFORMANCE STANDARDS

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The minimum performance standard for certification of evaporative emission control systems on spark-ignition marine ~~vessel~~watercrafts is contained in CCR Title 13, Chapter 15, Article 4, section 2855.

3. ~~PRE-CERTIFICATION~~DURABILITY REQUIREMENTS

3.1 ~~Durability~~

A demonstration of durability of the applicant's evaporative emission control system is required prior to performing an evaporative emissions test.

Prior to the commencement of a durability demonstration, the applicant is required to submit and obtain approval of an evaporative emission durability test procedure. The test procedure must subject all evaporative emission control system components to conditions representative of those likely to be experienced throughout their useful life. Once the emission durability test procedure is approved, the approval remains valid for certifying all subsequent model years provided that no major changes are made to the evaporative emission family control system. If major changes are made to the evaporative control system, the previously approved durability test procedures no longer apply and approval of a revised durability test procedures is required.

A durability demonstration is required prior to any testing to determine the performance of a carbon canister or pressure relief valve. These durability tests are designed to ensure that the carbon canister or pressure relief valve remains effective throughout the useful life of the equipment on which it is being used. The durability demonstration must follow the applicable requirements outlined in TP-1503 section 5.

4. GENERAL SUMMARY OF TEST PROCEDURE

A Sealed Housing for Evaporative Determination (SHED) is used to measure diurnal emissions. This method subjects spark-ignition marine ~~vessel~~watercrafts to a temperature profile while maintaining a constant pressure and continuously sampling for hydrocarbons with a Flame Ionization Detector (FID). The total mass of hydrocarbons from an evaporative control system over the test period is calculated using the ideal gas equation.

This test procedure measures diurnal emissions from spark-ignition marine ~~vessel~~watercrafts with complete evaporative emission control systems as defined in 13 CCR 2752 (a)(8). The basic process is as follows:

- Fill the spark-ignition marine ~~vessel~~watercraft's fuel tank to 55% with fuel
- Operate engine at 50% maximum governed speed for 15 minutes
- Precondition the evaporative emission control and fuel delivery system
- Drain and fill fuel tank to 55% capacity with fuel
- ~~—~~Purge carbon canister (if so equipped) with 400 bed volumes of nitrogen or dry air at the carbon
- ~~—~~canister manufacturer's recommended rate
- Operate engine at 50% maximum governed speed for fifteen minutes to allow the engine to reach normal operating temperature

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- Subject the ~~vessel~~watercraft to a three-hour constant 105°F hot soak procedure
- Soak the ~~vessel~~watercraft until fuel temperature reaches 65°F
- Subject the ~~vessel~~watercraft to a 24-hour (65°F - 105°F - 65°F) diurnal temperature profile

The corrected diurnal mass of total hydrocarbons measured by the SHED over the 24-hour diurnal temperature profile is compared with the performance standard in CCR Title 13, Chapter 15, Article 4, section 2855. Evaporative control systems that achieve results less than or equal to the performance standard are considered compliant.

5. INSTRUMENTATION

The instrumentation necessary to perform evaporative emission testing for spark-ignition marine ~~vessel~~watercrafts is the same instrumentation used for passenger cars and light duty vehicles, and is described in 40 CFR 86.107-96.

5.1 Calibrations

Evaporative emission enclosure calibrations are specified in 40 CFR section 86.117-90, as incorporated by reference amended with the following subsection:

~~(1)§1.1~~ The diurnal evaporative emission measurement enclosure calibration consists of the following parts: initial and periodic determination of enclosure background emissions, initial determination of enclosure volume, and periodic hydrocarbon (HC) and ethanol retention check and calibration. Calibration for HC and ethanol may be conducted in the same test run or in sequential test runs.

- All test fuels must be tested to ensure they meet ARB specification for E10 CERT fuel. Fuel analysis certification results from a fuel supplier are sufficient to meet this requirement.
- The SHED must be able to control temperature to within the specification of this test procedure while keeping pressure constant.

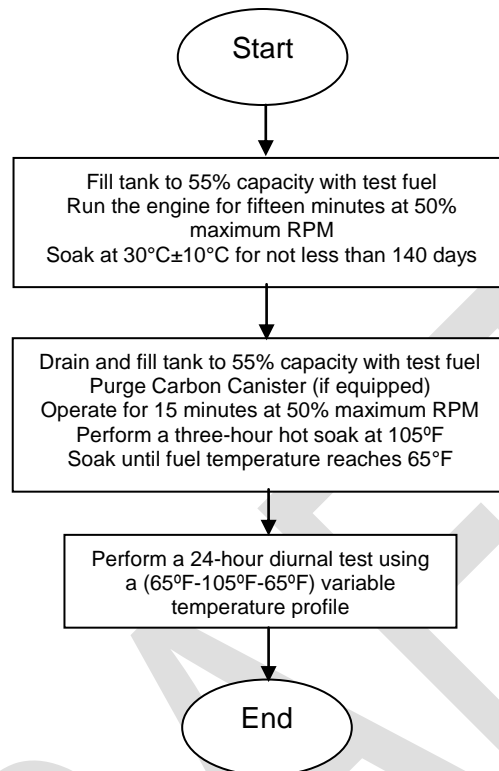
6. TEST PROCEDURE

The test sequence overview is shown graphically in Figure 1. The temperatures monitored during testing shall be representative of those experienced by the equipment. The equipment shall be approximately level during all phases of the test sequence to prevent abnormal fuel distribution. The temperature tolerance of a soak period may be waived for up to 10 minutes to allow purging of the enclosure or transporting the equipment into the enclosure.

Testing a representative piece of equipment from each evaporative family and comparing the results to the appropriate performance standard determines compliance with requirements of CCR Title 13, Chapter 15, Article 4, section 2855. The 24-hour diurnal test sequence is shown in Figure 6.1.

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**Figure 6.1 Flow Chart of
Test Procedure**



6.1 Fuel Tank / Fuel System Preconditioning

The purpose of the preconditioning period is to introduce gasoline into the fuel system and precondition all fuel system components. Precondition the tank and other fuel delivery system components by filling the tank to 55% of its nominal capacity with fresh E10 CERT fuel as specified in Section 7 of these procedures. After filling the tank start the engine and allow it to run at 50% of the maximum rated speed for approximately fifteen minutes. Soak the tank and other components at 30°C \pm 10°C for not less than 140 days. Data documenting that the tank has reached equilibrium must be provided for tanks soaked less than 140 days. The period of slosh testing may be considered part of the preconditioning period provided each tank and all fuel system components tested remain filled with fuel and are never empty for more than one hour over the entire preconditioning period.

6.2 Refueling and Hot Soak Procedure

Following the preconditioning period, drain the fuel tank and refill to 55 percent of its nominal capacity with E10 CERT fuel. For evaporative emission control systems that use a carbon canister, the canister must be purged following the preconditioning period but prior to initiating the hot soak procedure. The sequence starts by first bench purging the canister with 400 bed volumes of dry air or nitrogen in 30 minutes. Bed volume is the design volume of the carbon contained in the canister. The purge rate will therefore vary with canister size. Purge may be accomplished by drawing a vacuum at the tank or purge port, or by pushing air or N2 into the atmospheric vent. Operate the engine at 50%

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of its maximum governed speed for fifteen minutes. Immediately place the engine in the SHED enclosure preheated to 105°F within two minutes. Perform a three-hour hot soak at a constant 105°F.

6.3 Forced Cooling

After the hot soak procedure, purge the enclosure to reduce the hydrocarbon concentration to near background levels. Cool the enclosure to attain a wall temperature of 65°F ± 3.0°F. After cooling the enclosure to 65°F, soak the ~~vessel~~watercraft in the enclosure until the fuel temperature reaches 65°F ± 3.0°F.

6.4 24-Hour Diurnal Test

Immediately after soaking, purge the enclosure to reduce the hydrocarbon concentration to near background levels and perform a 24-hour diurnal test by smoothly following the temperature profile shown in Table 6.1.

Table 6.1
Diurnal Temperature Profile

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12
(°F)	65.0	66.6	72.6	80.3	86.1	90.6	94.6	98.1	101.2	103.4	104.9	105.0	104.2
Hour	13	14	15	16	17	18	19	20	21	22	23	24	--
(°F)	101.1	95.3	88.8	84.4	80.8	77.8	75.3	72.0	70.0	68.2	66.5	65.0	--

6.5 Calculation of Mass of Diurnal Evaporative Emissions

The calculation of the mass of the diurnal evaporative emissions is as specified in Part III of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles."

7. TEST FUEL

E10 CERT Fuel is California certification gasoline as specified in "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" Section II.A.100.3.1.2 as adopted March 22, 2012, as incorporated by reference herein.
~~Fuel: defined as the interim E10 CERT fuel until the adoption date of a California E10 certification fuel. The interim E10 certification fuel (see table 7.1 below) can continue to be used until one year after the adoption of a Californian E10 certification fuel.~~

Table 7.1—E10 CERT Fuel Specifications

Fuel Property	Limit	Test Method
Octane (R+M)/2 (min)	91	D2699-88, D 2700-88
Sensitivity (min)	7.5	D 2699-88, D 2700-88
Lead, g/gal (max) (No lead added)	0-0.01	Title 13 CCR §2253.4(e)

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Distillation Range-°F		Title 13 CCR §2263
50 pct. point	205-215	
90 pct. point	310-320	
EP, maximum	390	
Residue, vol% (max)	2.0	
Sulfur, ppm by wt	8-11	Title 13 CCR §2263
Phosphorous, g/gal (max)	0.005	Title 13 CCR §2253.4(c)
RVP, psi	6.9-7.2	Title 13 CCR §2263
Olefins, vol %	4.0-6.0	Title 13 CCR §2263
Total Aromatic Hydrocarbons, vol%	20-22	Title 13 CCR §2263
Benzene, vol %	0.6-0.8	Title 13 CCR §2263
Methyl tertiary-butyl ether, vol % (max)	0.05	Title 13 CCR §2263
Ethanol, vol %	9.8-10.0	
Additives: Sufficient to meet requirements of Title 13, CCR §2257		
Copper Corrosion	No. 1	D-130-88
Gum, Washed, mg/100 ml (max)	3.0	D-381-86
Oxidation Stability, minutes (min)	1000	D-525-88
Specific Gravity	Report	
Heat of Combustion	Report	
Carbon, wt%	Report	
Hydrogen, wt%	Report	

8. ALTERNATIVE TEST PROCEDURES

Test procedures, other than specified above, shall only be used if prior written approval is obtained from ARB's Executive Officer. In order to secure the Executive Officer's approval of an alternative test procedure, the applicant is responsible for demonstrating to the Executive Officer's satisfaction that the alternative test procedure is equivalent to this test procedure.

- (1) Documentation of any such approvals and demonstrations shall be maintained by the ARB Executive Officer and shall be made available upon request.
- (2) Once approved for use, an alternative test procedure may be used and referenced by any manufacturer subject to the limitations and constraints in the Executive Order approving the alternative test procedure.

9. REFERENCES

1. California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, California Environmental Protection Agency, Air Resources Board, El Monte, CA, 2000.
2. California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, California Environmental Protection Agency, Air Resources Board, El Monte, CA, 2002.
3. Control of Emissions from New and In-use Highway Vehicles and Engines, Code of Federal Regulations, Title 40, Part 86, 1995.

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